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The "Road to vision" : an electronic information system

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The "Road to Vision": An electronic information system

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THE "ROAD TO VISION": AN ELECTRONIC INFORMATION SYSTEM

A Project Report

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The Office of Graduate Studies

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In Partial Fulfillment

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Master of Arts

By

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ABSTRACT

THE "ROAD TO VISION": AN ELECTRONIC
INFORMATION SYSTEM

by Michael A. Rowe

Traditional printed reference and instructional materials are becoming inadequate to keep up with the mass and diversity of information required to perform adequately in many sectors of today's society. Computer-aided "electronic information systems" are being developed to cope with this information explosion.

If electronic information systems are to perform as efficiently as possible, it is important that design principles be developed to aid developers of these systems. This report describes the design of, and the design principles used in, an electronic information system. The report covers the rationale for using electronic information systems. Organizational methods and information access design principles for electronic information systems are described. Examples of different organizational and access methods are given. An electronic information system designed to be used as an instructional and reference aid for machine vision systems is described. The hardware and software tools used in creating this electronic information system are presented.

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1
Why This Project?

Currently, a confluence of three events is occurring that demands new methodologies for dealing with complex information systems. The three events are:

- Dramatic improvement in computer processing power coupled with major cost reductions in computer hardware.
- The development of sophisticated software programs for dealing with information in all formats (written, electronic, and visual), coupled with increasingly sophisticated computer users.
- A crush of massive bodies of information that are required to perform job related and personal tasks—bodies so massive that no individual can ever hope to acquire the entire body.

Many organizations are discovering the need to move away from the paradigm of completely training a person in a given discipline (or sub-discipline) towards the paradigm of training people in the use of information resources. For example, Amdahl Corporation has found that its products are now so complex, varied, and intermixed with other equipment that service personnel have no chance of learning even a significant portion of what they will be called on to know. Amdahl's reaction to this situation has been to devise an "information processing and retrieval system" that puts the company-wide resources at the immediate disposal of each service engineer. The retrieval system is driven by an expert system that allows engineers to navigate the mass of available data quickly and zero in on the data needed for the current project. The available data includes technical references, training manuals, instructional videos, databases holding information on previous service work, and other available performance support services *[1]*.

Projects of this magnitude are referred to as "Electronic Performance Support Systems" (EPSS). Electronic Performance Support Systems represent attempts at all-encompassing solutions to information organization, cataloging, and retrieval *[17]*. The software and methodologies developed for these large-scale systems will most likely filter into smaller systems and influence how information will be organized and presented in the future.

On some scale, organizations will find that effective access to information, rather than personal acquisition of information, will define the effective, productive individual of the future. The information explosion has hit with a vengeance. This project attempts to define structures that will help make electronic information systems effective tools that will increase a person's effectiveness in dealing with information sources.

1.1 Project Goals

This section describes the goals for this project.

1.1.1 Design an Electronic Information System for a Complex Subject

The electronic system should function as both a teaching and reference tool. It should be usable by both novices and sophisticated users. "Electronic documentation" will definitely become a more dominant aspect of technical writers' jobs. This project was selected to allow exploration of the methodology and resources involved in producing electronic information systems.

1.1.2 Explore Access and Organizational Strategies

Reading and personal experience with electronic documentation has led to the conclusion that information organization and access methods are two key elements of a successful electronic information system. Attendees at the International Hypertext Workshop in 1987 identified the problem:

> The classical hypermedia problem is the "getting lost problem," which becomes more severe as the database grows larger. If the reader begins to fear that she is overlooking crucial information or if she feels lost in a maze of hypertext links, the reader will abandon hypertext and insist on conventional media. *[7]*

Another group of hypertext developers expressed the problem in the following words:

> Because hypertext is a way of organizing information with enormous flexibility, information overload is only too easy to achieve, leading to concerns of being "lost in space" and unable to manage or organize the accessed material. *[19]*

Recent studies have shown that human memory is a process of organizing and relating information. We create meaningful blocks of information and then build associative networks that relate these blocks of information. The building of information blocks (sometimes called "chunking") is an iterative, organic process. Multiple exposures to the same information create stronger, more well defined chunks. Multiple associations between external stimuli and information blocks build stronger associative bonds. And, as has been pointed out, disuse weakens and obliterates the bonds *[3]*.

The hypothesis of this project is that confusing and difficult to use hypermedia implementations result from the failure to organize the information system properly and from failure to provide adequate, well-designed access methods.

Poor organization methods generally fail to recognize the natural "chunking" people use when acquiring information. Inadequate access methods generally fail to recognize the need for logical, repetitive interaction with an information system.

In working toward this goal, the form of traditional printed material was used as a starting point. Four hundred years of trial and error in printed media have produced a body of design principles for creating effective learning and reference materials. It is primarily the expanding mass of information and the speed at which new information is being added—not any inherent problem with printed material—that is creating the need for new ways of dealing with information.

As ways of organization and accessing material were examined, note was first taken of how traditional print methods organize material and provide access to the material. These methods were then imitated and changed when they could be made more efficient and easy to use.

1.2 Project Tools

The project, which is called the "Road to Vision," was developed using the following tools:

1.2.1 The Apple Macintosh Family of Computers

Of all systems available, Macintosh affords the computer platform with the most sophisticated capabilities for developing an interactive, multi-media information base. The majority of currently installed Macintosh systems are not powerful enough to drive the project's information base effectively. However, this project is intended as a demonstration of effective information system design for the next generation of computers, not as a currently implementable system.

1.2.2 SuperCard

The software used to create the project is an "authoring" system called SuperCard. Authoring systems are software programs that attempt to put the full power of computer programming into the hands of people who are not programmers or technically sophisticated computer users. The first authoring system is generally considered to be SmallTalk, developed out of Xerox Palo Alto Research Center. SmallTalk defined many of the features of the Apple computer interface, as well as subsequent computer Graphical User Interfaces (GUIs). HyperCard is the most wide spread and well known of the growing body of authoring systems. SuperCard is a super-set of HyperCard, incorporating all the features of HyperCard while adding many sophisticated features that make it a legitimate application development environment *[18]*.

Authoring systems attempt to make "everyman" a computer programmer by being "object oriented." Object oriented means that the software program provides you with a group of predefined, generalized objects. What the developer does is specify actions to be taken when an object is activated. A "button" is the most common object in authoring systems. Writing the code to display, monitor, and react to a button is complex, while writing the code to define the action taken when a button is pressed is much simpler (although not trivial). For simple applications, HyperCard-type systems give computer novices a convenient introduction to the process of developing computer applications, but to create complicated programs still requires a modicum of computer training. For this project, the primary advantage of an authoring system was to relieve the author of the tedious task of creating the objects while freeing him to concentrate on building the application.

The major capabilities of SuperCard are:

1. It incorporates two animation protocols and supports several others.
2. It incorporates both draw (vector oriented) and paint (rastered) graphics formats. (8-bit color is supported.)
3. It provides the following objects:
    a. Fields (text, scrolling, and pick list)
    b. Buttons
    c. Draw and paint graphics
    d. Windows (plain, palette, scrolling, modal)
    e. Backgrounds
    f. Cards
    g. Menus (pull-down, cascading, and pop-up)
4. It allows stand-alone, royalty free run-time applications to be produced.

5. It provides access to the standard Macintosh tool box for operations such as dialog boxes, diskfile operations, and resource fork manipulation.
6. It allows creation of custom icons and cursors.

1.2.3 Adobe Illustrator

While SuperCard provides a full set of paint and draw tools, the author finds Adobe Systems, Illustrator 3.0 a much better graphics program. All the graphics and animation art were created in Illustrator and imported into SuperCard *[12]*.

1.3 Other Resources

In most cases, building an electronic information system will not be a "start from scratch" operation. There will already exist resources in a variety of forms that can be incorporated into the electronic system. These resources include: existing written documentation, the electronic files for written documentation, video source material in a variety of formats, other electronic information systems, and existing training materials.

These resources should be used as extensively as possible so development of the electronic information system becomes a manageable task. Scanners, file conversion programs, Optical Character Recognition (OCR) programs, and video digitizer hardware are resources that will allow conversion and storage of disparate forms of information in an electronic medium.

For this particular project, the main existing resources were the electronic files for the written product documentation. The author also had access to electronic files for the documentation art work. The electronic text files were converted to an unformatted ASCII format using a utility provided by the text formatter that created the documentation. The electronic artwork was in a form that could easily be imported directly.

2
Project Design Guidelines

Recognizing that fact that "easy to use" systems depend on a shared experience by users, Apple Computer, Inc. has developed a series of "human interface guidelines."*[4]* These guidelines specify common elements and practices that should be followed when designing computer interfaces. Adherence to these guidelines has been a major factor in creating the perception of Apple computers as being easy to use. In fact, the guidelines have proven so successful that most computer software suppliers have adopted, in some form, most of the human interface guidelines. This project attempted to adhere closely to the Apple guidelines.

2.1 The Apple Human Interface Guidelines

Following is a brief summary of the Apple human interface guidelines.

2.1.1 Use Metaphors from the Real World

Learning and performance are enhanced when they are built on existing skills and knowledge. Making computer interfaces reflect the real world they are representing makes the systems easier to learn.

2.1.2 Direct Manipulation of Objects

Frustration with early computer systems stemmed a great deal from the "mystery" involved in "executing a command." Users typed something into the computer, pressed the return key, and hoped something desirable came out the other end. They were quite divorced from the productive actions taking place within the computer. The familiar "clicking" and "dragging" of modern computer interfaces helps remove this sense of alienation from the process, and encourages experimentation and mastery of computer skills.

2.1.3 See-and-Point

Do not require a user to remember command strings. Present the user with all options in a point and click fashion.

2.1.4 Consistency

Allow users to build the expectation that whenever they perform a given action, they should expect a given result. This is critical within an application and important across applications. Help the "community of users" develop a common set of skills that they can apply to multiple applications.

2.1.5 What You See Is What You Get (WYSIWYG)

This implies that not only should the screen represent the final output, but that the system should always let you know what it is doing. The results should not surprise the user.

2.1.6 User Control

The user should initiate all actions and should be able to terminate those actions.

2.1.7 Feedback and Dialog

This is the other half of user control—the user should always know what is going on and be presented with all options when a decision must be made.

2.1.8 Forgiveness

Allow users to recover from mistakes. An "Undo" capability and "Are you sure?" -type warnings should be an integral part of any application.

2.1.9 Perceived Stability

Programs should work, and not only under certain circumstances.

2.1.10 Artistic Integrity

Visually appealing, well-balanced screen presentations will help incline users more favorably to an application. Just as a printed page should have a proper balance of white space and an integrated appearance that reinforces the subject matter, so a computer screen should be designed to enhance the task.

2.2 Other Design Guidelines

One facet of making the information organization an aid to users is to make the presentation of the information reflect the organization of the information. This project made every effort to make the real world organization of the information space apparent to the user by reflecting the organization in the access methods designed to navigate the information space.

Another important goal was to make sure the project could run on all Macintosh computers.

3
Organizational Paradigms

As mentioned above, a guiding principle used in creating this project was

> The organization and presentation of information will be most effective when they reflect the natural organization of the material.

In exploring organizational methods, the author found the following terms to be useful:

information system	Refers to the total collection of information available to a user when accessing a computer-controlled resource like the one described in this report.
information block	Refers to a subset of related information. Information blocks can themselves belong to a higher level information block.
chunk	Refers to a piece of information within a block. An information system comprises a hierarchically organized collection of information blocks, which are in turn made of chunks.

The different organizational schemes used in the project are presented next. Four organizational paradigms were found to be useful. They are sequential organization, network organization, tree (hierarchical) organization, and idiosyncratic organization. In addition to describing these organizational paradigms, three principles for accessing the organized information will be suggested.

Figure 1 shows the four different types of organization. The text following summarizes each organization and suggests the types of information the organization is suited to.

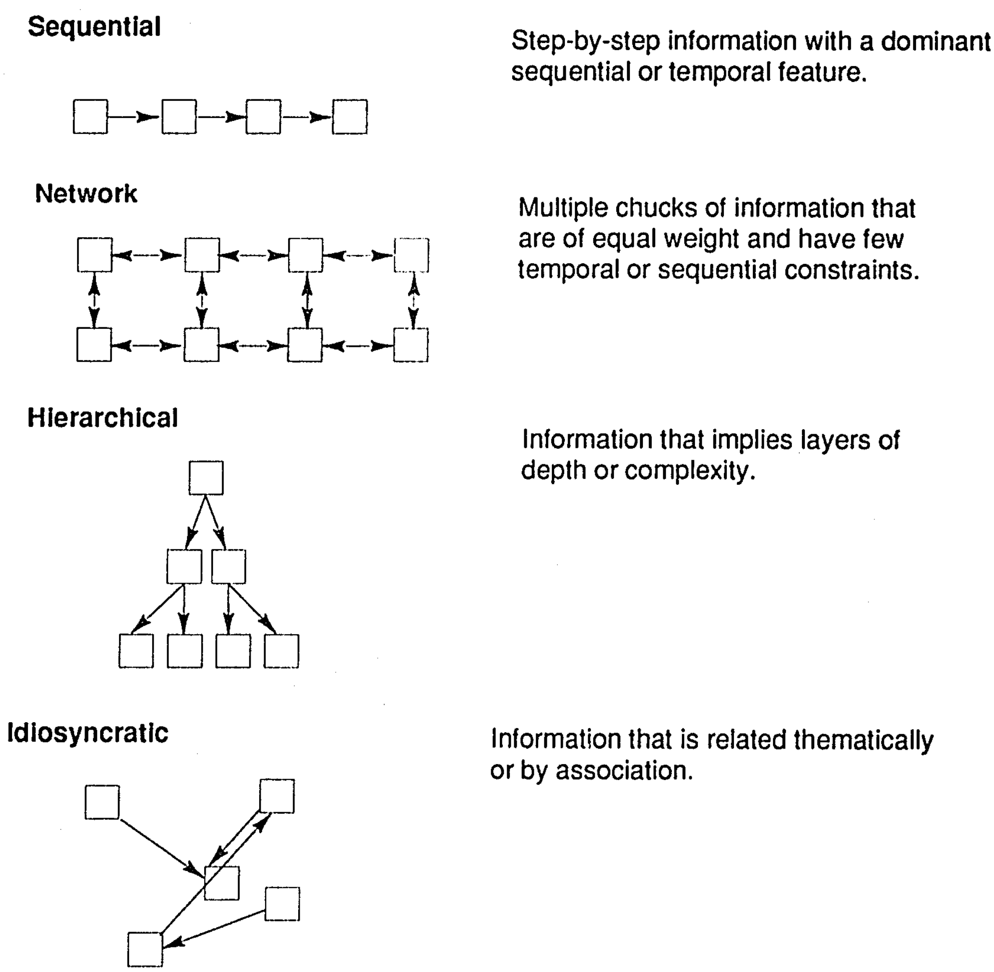

Figure 1. Organizational Paradigms

3.1 Sequential Organization

A sequential organization implies a strong temporal or step-constrained character to the information. Repair procedures are classic examples of information presented in a sequential organization. First you perform step one, then step two, etc.

Computer-based instructional resources have tended to rely heavily on sequential organization (largely because of the limitations of the technology). There are several simple methods of showing that information is sequentially organized that are easily recognized by the community of users. A status bar showing "step x of y" is often used. A simple bar that is shaded to show the relative location in an information block is a more graphic method of showing a sequential organization. The ubiquitous "scroll bar" used in graphics based operating systems is an excellent clue to sequential organization because it not only identifies the organization and orients users to their location in the organization, but also provides an access method.

Figure 2 shows a sample card from the "Road to Vision" that demonstrates sequential organization. In this case, clicking on the "Look behind the lens" button displays the next page in the serially organized information block.

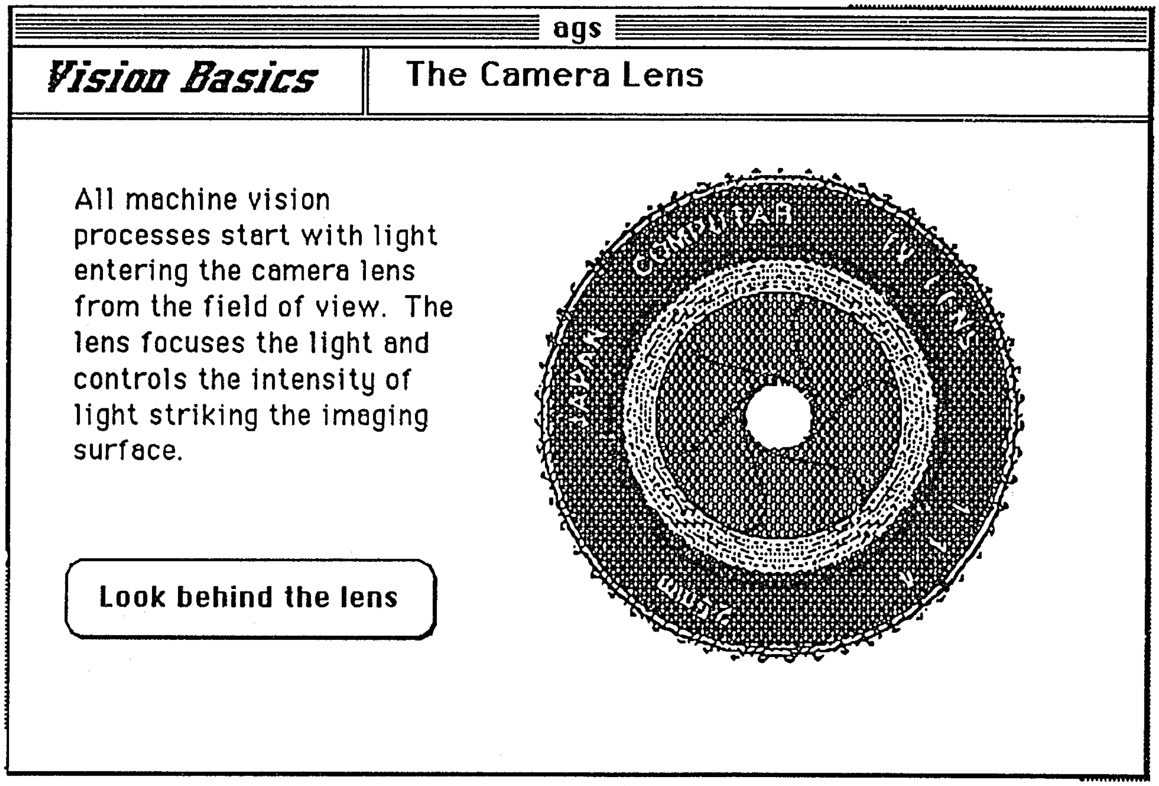

Figure 2. Sample Card Demonstrating Sequential Organization

3.2 Network Organization

Often, bodies of information possess a very democratic character— the information block consists of related topics (chunks) that are of equal weight. No single chunk of the information is more important or has logical precedence over any other chunk within the information block. This type information is best presented in a "network" fashion. The information chunks within the block can be accessed randomly. Networked information also implies that learning about one topic is not tightly constrained to previous learning of other topics within the information block.

The major subsystems of an automobile provide an example of information amenable to this type of organization (see Figure 5). A car has electrical, brake, transmission, and other systems. A complete understanding of a car implies understanding of each subsystem, but there is no clear temporal or step-constrained learning sequence that must be adhered to when learning the different systems.

Figure 3 shows a sample card from the "Road to Vision" that provides access to a network information block. The topics are arranged alphabetically in equally sized type to indicate that all topics reside at the same level of importance. If the design of this card is successful, a user should not be able to infer any serial or hierarchical relationships among the topics. The information accessed by the card in this example is a group of instructions for programming a computer. Each instruction is nearly equal in importance and difficulty, and learning to use one instruction does not require knowledge of other instructions. In this case, the access method (an array of radio buttons) suggests that the information is arranged in network fashion. Users are free to choose the next topic, and the alphabetic arrangement of buttons suggests that all topics are of equal importance.

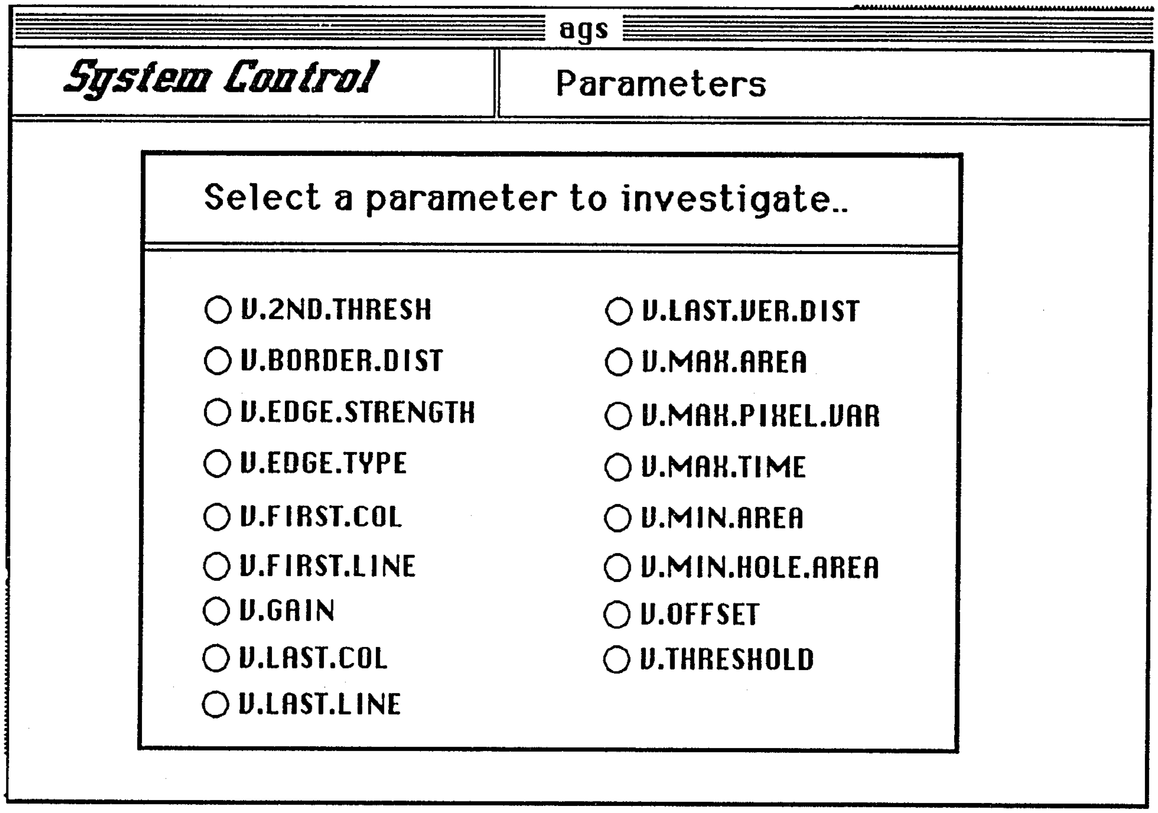

Figure 3. Sample Card Demonstrating Network Organization

3.3 Tree (Hierarchical) Organization

Information that implies layers of depth is best organized in a tree structure. The term "tree" is used rather than hierarchy because the visual image of information trees (family trees for example) is useful in making the organization apparent to the user.

The learning of information at deeper levels of a tree is strongly constrained by the acquisition of information at all previous levels. In many cases, the tree also implies that users can decide how deep to go in the information block.

Most bodies of scientific knowledge are well suited to organization in a tree. Heredity, for example, can be understood at the very elementary level of physical feature inheritance. (Remember learning in high school biology how some people could roll their tongues and others could not?) A deeper level would cover the principles of chromosome passing, followed by the RNA/DNA replication processes. The information block could go as deep as the molecular structure of the proteins making up the RNA strands. In all cases, a full understanding of the deeper levels requires understanding of the higher levels.

For simple trees, the designer could use a picture of a tree as both an access method and a clue to the organization. For more complicated trees, the branches will quickly expand to the point where this becomes impractical. One solution is to "truncate" parts of the tree and show only the immediate area the user has been working in. Another solution is to show only the next higher and lower levels on the screen the user is currently working on.

The "Road to Vision" project does not make extensive use of hierarchical structuring, although the entire information system is organized in a loose hierarchical fashion (see Figure 6).

3.4 Idiosyncratic Organization

Idiosyncratic organization organizes information based solely on the fact that topics are conceptually or thematically related. This is the organization that many people associate with a hypermedia-driven information system. While it can be argued that this is not really an organizational method, this paper argues that treating it as an organizational method will result in less confusing and more usable hypermedia systems. The temptation is to throw idiosyncratic links into a system whenever one feels a connection, thus contributing to the "lost in space" feeling. If these links are considered at the top level of design, and idiosyncratic links are considered as creating their own coherent, well-thought-out information block, better hypermedia productions should result. Herrstrom and Massey suggest:

> To deliver computer systems that people can use, we must engineer the "user support" every bit as carefully as the computer tool itself. In designing user documentation that employs hypertext systems, this means that we accept the responsibility as designers for providing the right information nodes and links, rather than burdening users with a plethora of choices with only a few relevant to their needs. *[6]*

For example, anatomy is a complex interrelated subject. A body can be broken into subsystems, but a complete understanding of basic biological processes (such as the oxygen-carbon dioxide cycle) is dependent on understanding of elements in several sub-systems.

A characteristic of most idiosyncratically related information blocks is that particular chunks of information in a block usually reside in other information blocks. This is the type of organization we most commonly think of when referring to Hypertext or Hypermedia systems.

By its nature, idiosyncratic organization is difficult to make apparent to the user. A few options are:

- Make it obvious when the user is selecting an idiosyncratic move within an information block.

- Make it obvious when a user has reached a location as a result of an idiosyncratic move.
- Use general clues in the overall design of the system that orient the user to the existence of different information blocks.
- Provide a mechanism for retracing the steps a user took while navigating an idiosyncratically organized block.

In Figure 5 the arrows that point "up" the tree represent an idiosyncratically organized information block that contains chunks from both tree structured and serially structured information blocks.

Figure 4 shows a sample card demonstrating idiosyncratically organized information. The user can click on any one of the steps ("ENABLE V.BOUNDARIES," "VPICTURE," etc.) or on the "Next Step" button to access relevant information contained in different information blocks. (Unfortunately, the steps in this example imply a serial organization to the information that does not exist—the serial character is a result of the particular sequence of instructions in the example.) The information chunks accessed when clicking on "ENABLE V.BOUNDARIES" belong to one information block, "VPICTURE" to another, and "VQUEUE", "VLOCATE," and "VFEATURE" to another.

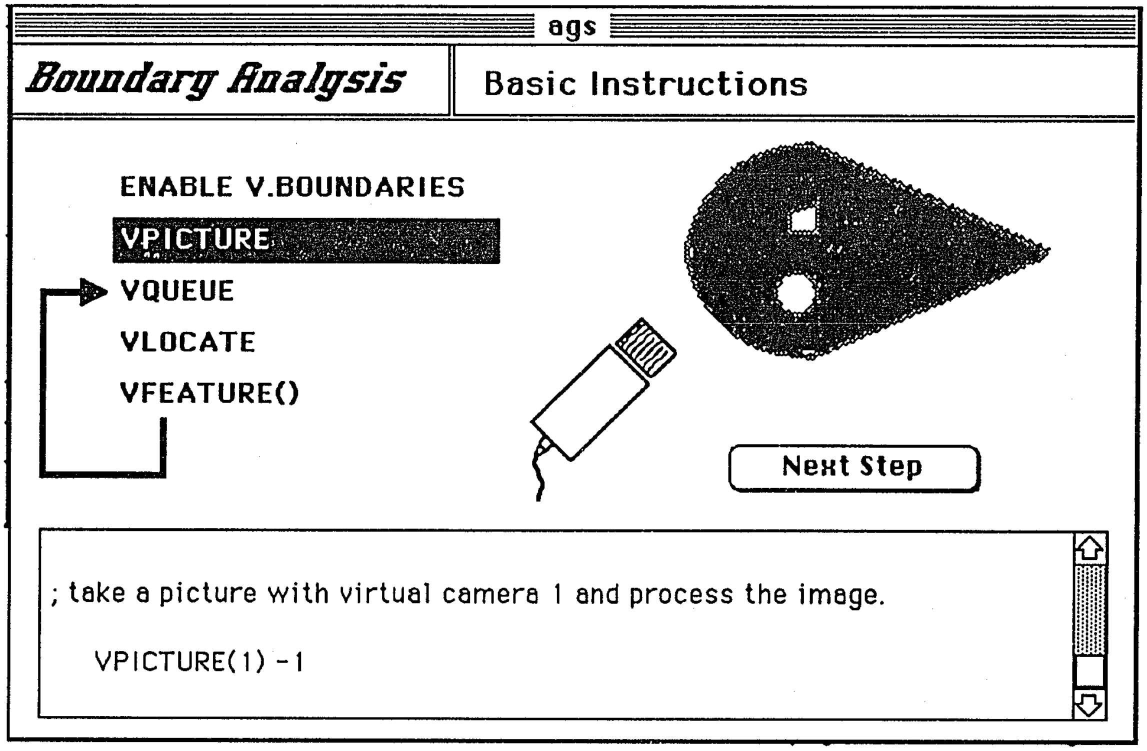

Figure 4. Sample Card Demonstrating Idiosyncratic Organization

3.5 A Sample Information System

One great advantage of electronic information systems is that multiple organizations can be employed. Information chunks can be organized in the most effective fashion, and multiple information blocks can also be organized according to the same principles. The net effect should be to localize information so that users feel comfortable within the information system and feel that they can move around and still maintain contact with where they are in the information system. A well-designed organization should also contribute to the users' sense of the organization, so that when they become more familiar with the material, they will feel more confident about pursuing the entire information system. The design should also help users organize and relate the information as they learn it. *[11]*

Figure 5 shows an information system for the mechanical systems of an automobile. Notice how the different organizations can be combined, nested, and referenced in an idiosyncratic fashion.

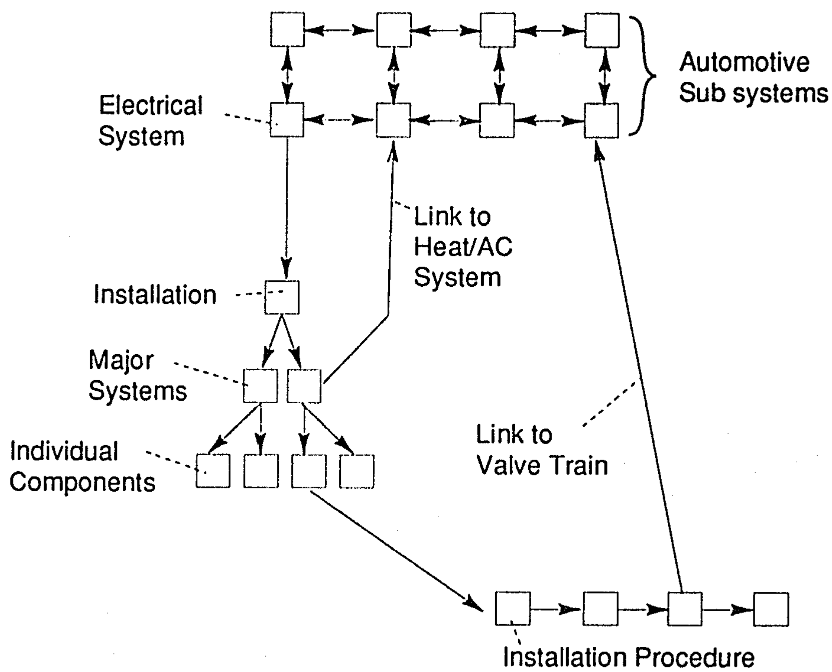

Figure 5. Information System for an Automobile

3.6 Applying Organizational Schemes

The first principle for applying an organizational scheme is: Use the organization that best reflects the information's natural organization. Herrstrom and Massey suggest:

> In designing the hierarchical array, the designer devises predictable paths to expected information. The array reveals its structure (say through maps and icons), aiding the user in

> creating an accurate mental model of the system's knowledge space. *[6]*

The second principle for applying an organizational scheme is: Make the information's organizational structure obvious to the user. Grice suggests:

> Users may well have arrived at the same location from very different starting points and thus have very different perceptions of their relative place in an information package. *[19]*

The third principle for applying an organizational scheme is: Create a skeleton of organization before creating the individual pieces of the hypermedia production. In much the same way that an outline is essential for good writing, the information structure needs to be defined before creating the pieces of an information system. Shneiderman suggests:

> Meaningful structures come first: Build the project around the structuring and presentation of information, not around the technology. Develop a high concept for the body of information you are organizing. Avoid fuzzy thinking when creating the information structure. *[25]*

3.7 Information System Map for the "Road to Vision"

Figure 6 shows the main information blocks in the "Road to Vision" information system. Each box represents a chunk of information. Boxes connected by horizontal arrows indicate a serial information block. Regularly spaced boxes connected by lines with no arrows indicate a network information block. Boxes connected by arrows pointing down represent a hierarchical information block. Irregularly spaced blocks connected by lines indicate an idiosyncratic information block. In the complete information map, each box would be filled in with a name identifying a chunk of information.

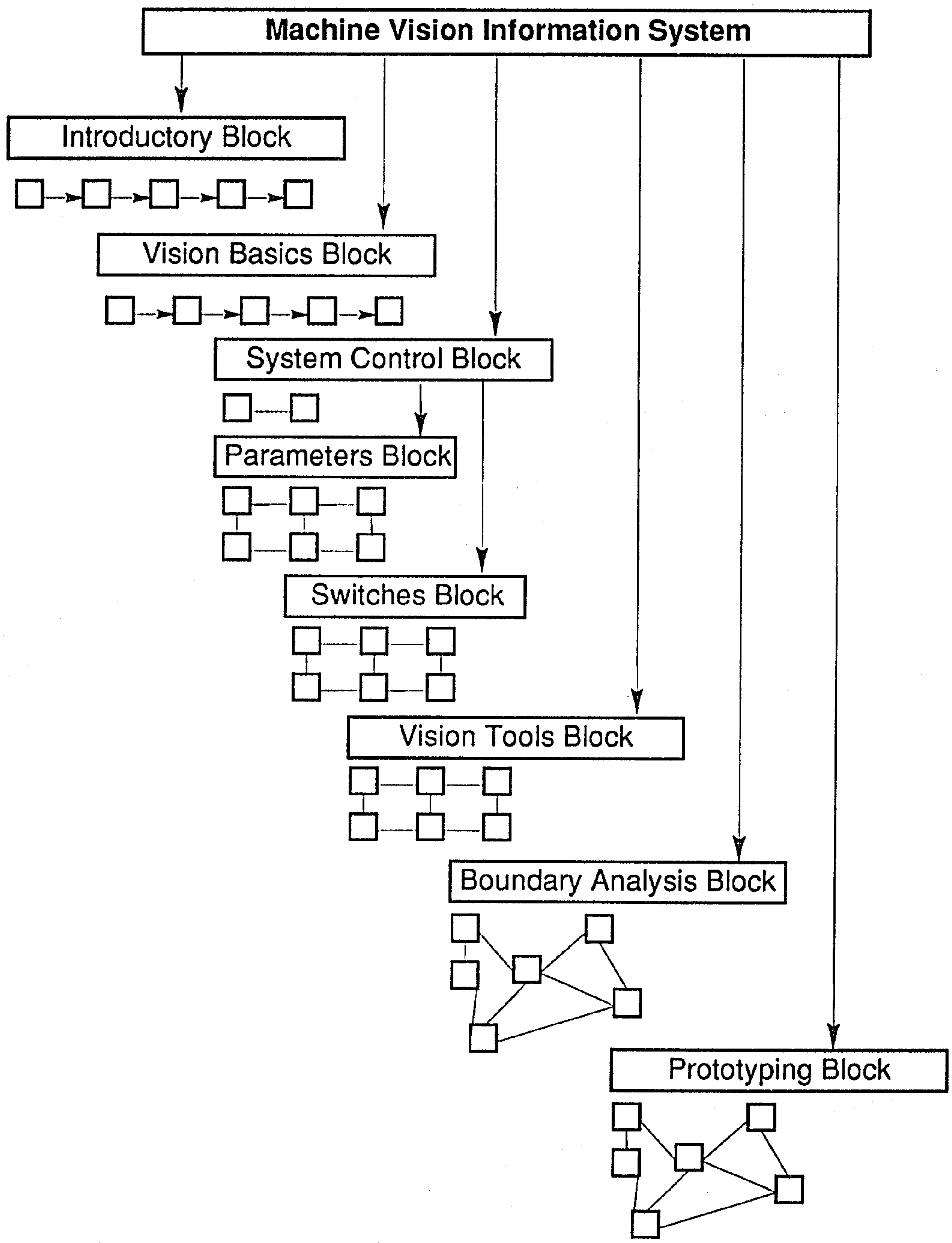

Figure 6. Information System Map

4

Access Methods

Well-organized information is not of much use if it is burdened with inadequate or poorly designed access methods. Schneiderman suggests that access methods should have the following characteristics:

> Ensure simplicity in traversal: Authors should design the link structure so that the navigation is simple, intuitive, and consistent throughout the system *[25]*.

In the "Road to Vision," consistent, intuitive, and simple means:

Consistent

Consistent access methods:

- Look the same way wherever they occur.
- Execute the same way whenever or wherever they are employed.

Intuitive

Intuitive access methods:

- Employ real-world analogies whenever possible.
- Clearly imply what they will do, and do not do any more or less.

Simple

Simple access methods:

- Employ a minimum of steps.
- Are consistent and intuitive.

Bernstein summarizes:

> It is essential to remember that the author is the reader's tour guide to a new and unknown place. It is important . . . to ensure that the reader doesn't get lost. *[7]*

When users select an access method, they should be relatively confident that:

- They will get somewhere they want to go.
- They can get back if they get somewhere they didn't want to go.

Two additional things were kept in mind when the access methods were designed for this project:

1. Methods were designed for both beginners and experienced users. As users become more proficient at using the information system, they require more sophisticated access methods.
2. Reaccess was considered as important as access.

Not only is it important to organize information properly in an electronic information system, it is critical that effective access methods be provided for getting at the material. The most elegantly organized information in the world will be useless if it is too difficult to get at.

The project employs three primary access paradigms:

Controlled/Bounded Access

In this type of access method, specific topics are presented to the user, and the user can access information on those topics only at predetermined points.

Controlled/Unbounded Access

For this access, specific topics are presented, but users can access information on those topics in multiple locations. The user controls how broad the search is.

Uncontrolled/Unbounded Access

For this access, the user selects the topics and controls the depth and breadth of the search.

In different situations, and with different levels of user expertise, different access paradigms should be used. A large information system will most likely use a number of access methods that fall into each category.

Carlson sums up the issue well when she writes:

> Attempts to produce a "superbook" have merged the forces of IR, DBMS, Hypertext, and AI to focus on the single critical issue of implementation: how to provide search procedures which are accurate, complete, and comfortable for the end user [13].

The following sections present examples of different access methods and discuss when each is most appropriate.

4.1 Controlled/Bounded Access

A controlled/bounded access method is useful for:

- Information being presented to novice users. The sense of "being lost" in the information can quickly defeat a new user.
- Presenting the sequential chunks in a serially organized block. This access method parallels the serial organization paradigm.
- Controlling hyperlinks. Limiting access in idiosyncratic organizations helps control and guide users to pertinent information without setting them free in a sea of data.

Figure 7 shows an example of one of the main access methods in "The Road to Vision"—related topics. Users are presented with selected topics that pertain to the current topic. Double clicking on the topic opens that topic's information chunk.

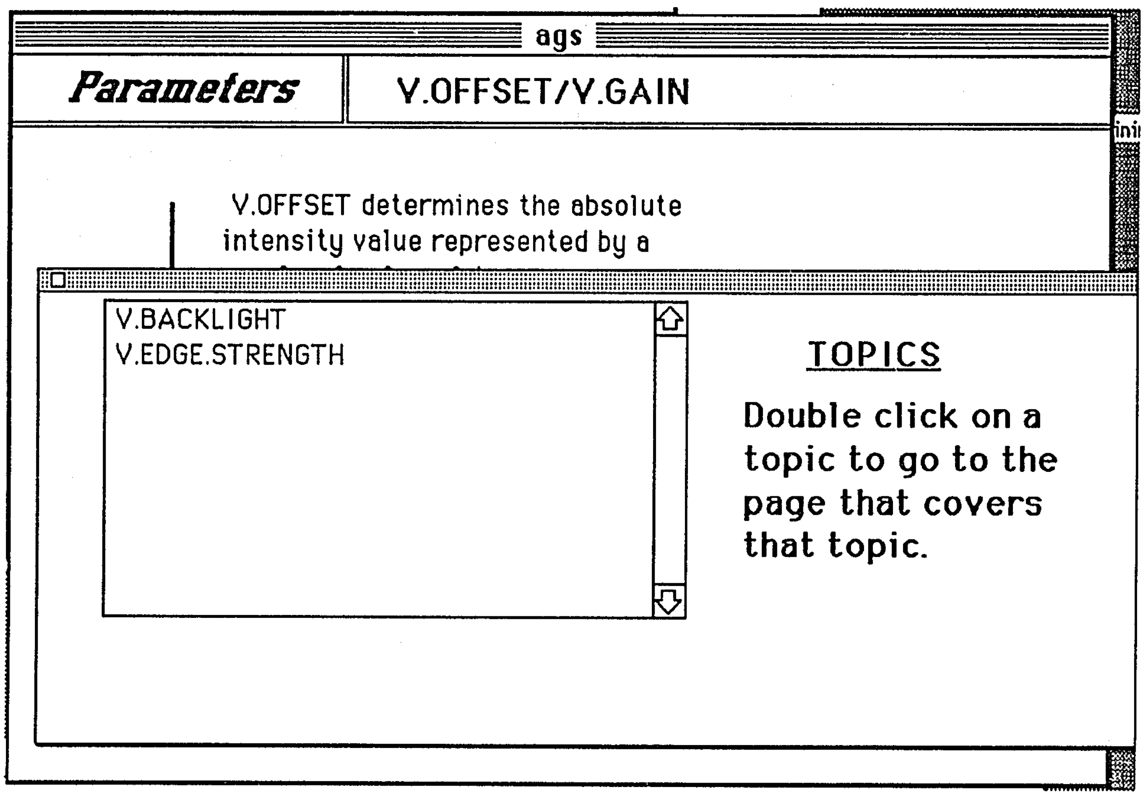

Figure 7. Sample Controlled/Bounded Access Method

Other controlled/bounded access methods in the "Road to Vision" include:

- The "Go Next," "Go Back," and "Go Previous" arrow buttons on the navigation window (see Figure 11).
- The "list of topics" type cards such as the one shown in Figure 3.
- The Table of Contents.

4.2 Controlled/Unbounded Access

Controlled/unbounded access methods are used when:

- A specific topic does not fit neatly into a single information chunk—several chunks may have to be visited before comprehensive understanding or learning takes place.
- Topics will be accessed in a "reference" fashion.

Figure 8 shows the main controlled/unbounded access method in the "Road to Vision"—an electronic index.

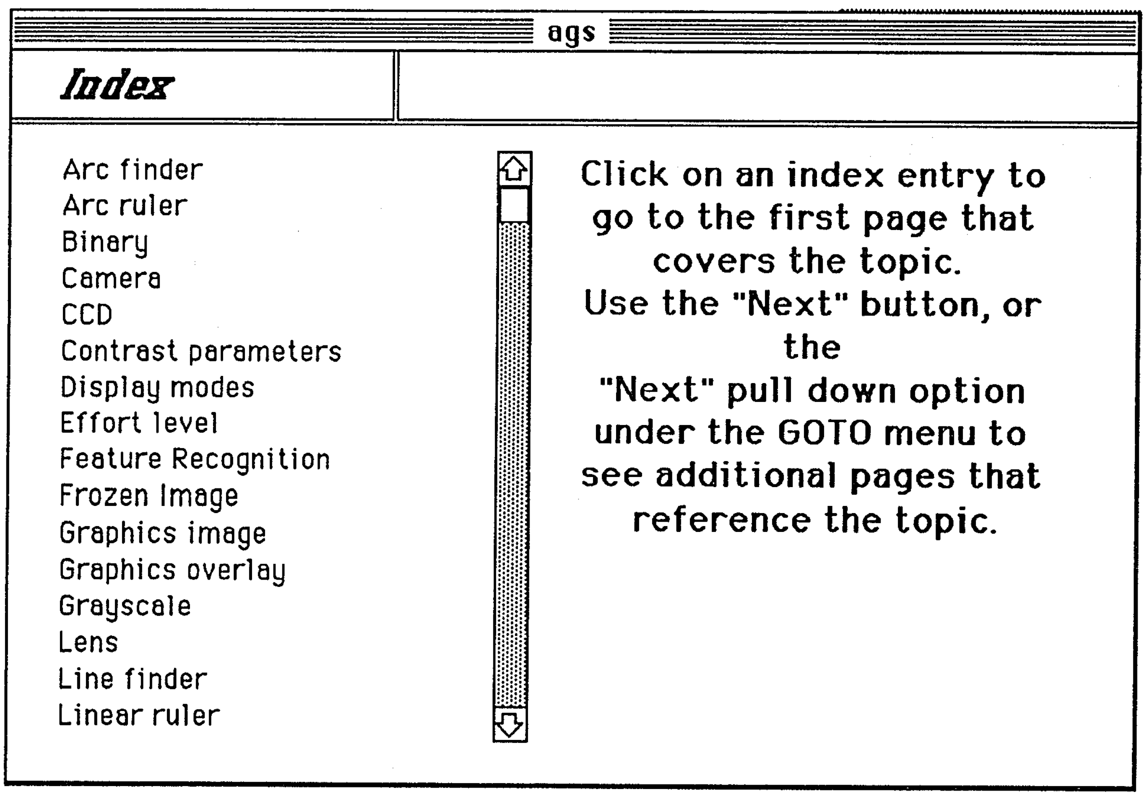

Figure 8. Sample of a Controlled/Unbounded Access Method

4.3 Uncontrolled/Unbounded Access

Uncontrolled/unbounded access methods are used when users have become familiar with the information map and are confident they can explore the information space in a productive fashion. This method allows users to define both the topics and extent of an access to the information system. In the "Road to Vision," the primary unbounded/uncontrolled method of access is a free-form text search. The user is asked for a text string, and all the text areas in the information system are searched for matches.[1] Figure 9 shows the dialog box presented to a user making a free-form search. This method is the most poorly developed in the project. An effectively developed method would suggest ways of bounding the search, and make suggestions based on the results of a search.

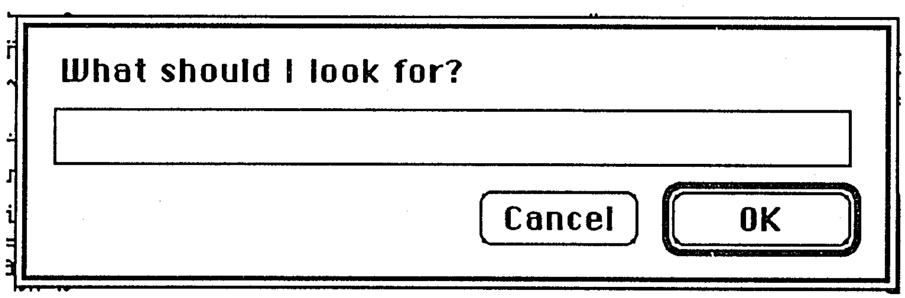

Figure 9. Sample of an Uncontrolled/Unbounded Access Method

4.4 Access Methods and Traditional Printed Material

When using a printed text or reference, readers have many clues as to their location in the information system that is presented in the book. The thickness of the book, folded page corners, paper clips and other book markers, page numbers, and headers and footers are examples of these clues. When designing

[1] As a pragmatic matter, there are a few text areas that could not be included reasonably in the text searches.

access methods for the "Road to Vision," these clues were imitated wherever possible.

5
The Project

Adept Technology, Inc., produces machine vision systems. These systems perform quality inspections for manufacturing processes and are used to guide robotic applications. A machine vision system is a complex collection of optics, video devices, computer hardware, and software programs.

Adept's machine vision system was selected for this project for the following reasons:

1. A machine vision system is a complex information system.
2. Learning to use machine vision systems is a difficult and on-going process. The initial learning is difficult. And after initial mastery is achieved, constant access to reference material is required when developing machine vision systems.
3. The author is familiar with the system and its procedures.
4. The author has access to the electronic files that generate the written documentation.

The project is a self-guided, self-paced electronic information system. The project uses the HyperCard "stack" paradigm to create a reference, instructional, and tutorial information system. The name of this project, "The Road to Vision," implies that learning to use machine vision systems is more a journey of progressive learning than a one-time educational experience. This idea is a key element of this project and—very likely—an element in most information systems that would be amenable to presentation in a manner similar to the "Road to Vision."

5.1 The Project Interface

The user interface for this project consists of three primary windows and a menu bar. The three primary windows are: the main window, the navigation window, and the details window.

5.1.1 The Main Window

Most of the instruction takes place in the main window. This window exactly fills the 9-inch screen of a Macintosh SE computer. The cards in this window fall into three general classes: introductory cards that present an idea, exploratory cards that elaborate on an idea, and navigation cards that provide access to a specific information block.

The introductory cards usually have a short textual introduction and a graphic or animation that illustrates the topic. The exploratory cards generally have additional text and user manipulatable objects (things the user can click on or drag to generate activity on the card). Access cards contain series of check boxes, scrolling pick lists, or other objects that allow access to other cards. Figure 10 shows a sample introductory card.

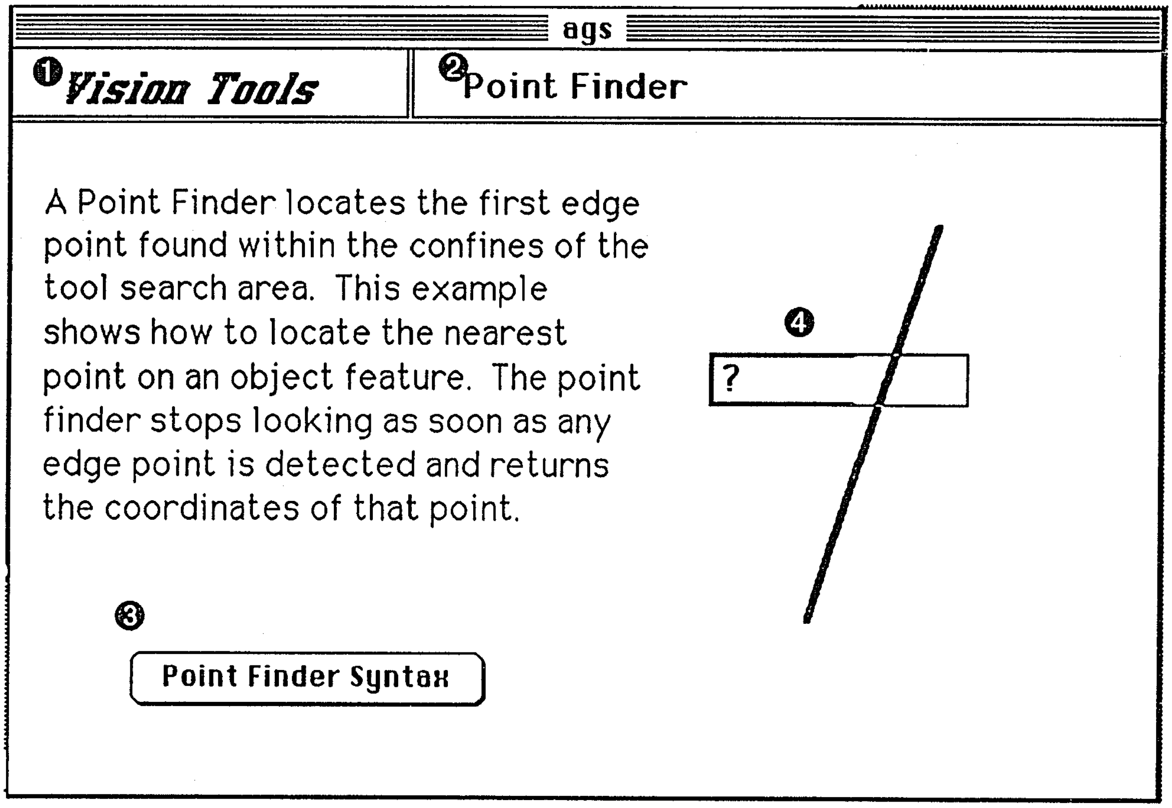

Figure 10. Introductory Card

The common elements found on a card in the main window are the following: (The numbered items in the following list refer to the numbers in Figure 10.)

❶ The left corner of the title bar shows the organizational block the card belongs to. Clicking on this corner of the title bar will take the user up one level in the organizational scheme. For example, the Point Finder described in the example card belongs to an information block organized in network fashion. Clicking on the title opens the access card showing all the options within the organizational block. If the information block represented by this access card belonged to another information block, clicking on the left side of its title bar would take a user back up to that organizational block. This scheme allows users to navigate the information system on the basis of information blocks. It is hoped that this type of navigation will help make the organization more apparent and the user more comfortable moving around the information system.

❷ The right side of the title bar shows the title of the current topic. If multiple cards illustrate a topic, they will all have the same title (imitating a running header in a book). Clicking on this side of the title bar will display the details window (described below).

❸ An introductory card will generally suggest only one option, going to the exploratory card for the topic.

❹ This graphic is animated. When the card is first displayed, the animation runs. The animation and graphics on an introductory card should complement the text so users have a good idea of what they will be seeing on the exploratory card.[1]

5.1.2 The Navigation Window

The navigation window is a "floating palette window." A Macintosh floating palette window is a window that "floats" on top of other windows but does not field any events[2] unless they are specifically directed at that window.

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1. In this report, the Macintosh convention of calling an individual screen a "card" is used. In the actual project, individual cards are referred to as pages in order to make a stronger connection to the book paradigm. (In fact, the IBM PC equivalent to HyperCard/SuperCard—which is called ToolBook—uses the terms book and page rather than stack and card to describe its objects.)

2. In GUI programming, code segments are executed based on detecting a system "event." System events include mouse clicks and drags, key presses, the internal Apple events, and input from peripheral devices such as printers or sound recorders.

Drawing tool palettes in graphics programs are the most common use of this type of window. The navigation window in the "Road to Vision" allows users to move from one card to the next, access the backlist and execute general text searches. The reasons for using a palette window are:

- Users can move the palette anywhere they find most convenient. They can also close it if it is not needed and is in the way. (The window is redisplayed by a key combination or menu selection.)
- The navigation options do not have to be placed on every card or background, thus freeing up space on the main card.

Figure 11 shows the navigation window.

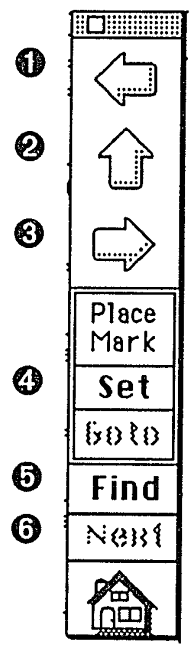

Figure 11. The Navigation Window

The options available through the navigation window are the following: (The numbered items in the following list refer to the numbers in Figure 11.)

1 Clicking on this arrow displays the previous card (turns back one page).

❷ Clicking on this arrow removes one card from the system backlist. Each time a card is displayed, it is placed in the system backlist. Accessing the backlist removes one card from the top of the list and displays that card. The system backlist creates a "bread crumb trail" of all cards a user has opened, and takes the user backwards through those cards.

❸ Clicking on this arrow displays the next card (turns forward one page).

❹ The two buttons on this group create a user backlist. Unlike the system backlist described in item❷, only the cards specifically selected by a user are placed in this backlist. Also, unlike the system backlist, the user backlist is saved between sessions, so users will still have their placemarkers when they "reopen the book." The book paradigm for the user backlist is placemarkers—scraps of paper placed in a book to remember certain pages. Clicking on **Set** places the current card in the backlist and clicking on **Goto** removes one card from the list and displays that card. A common problem in hypermedia systems occurs when a user wants to return to a certain card, but cannot remember how to get there. This option is an attempt to mitigate this problem. There are many instances in the project where an idiosyncratic link is made. In these cases, users are always asked if they want to place the current card in the user backlist before the next card is displayed.

❺ Clicking on **Find** implements a general text search of the stack. Clicking on **Next** searches for the next instance of the text search.

❻ Clicking on this button takes users to the start-up window, which contains a simple table of contents.

Notice that in Figure 11, the **Goto** and **Next** buttons are dimmed. This means that no cards have been placed in the backlist and a text search has not been made. This adheres to the Apple interface guideline of not allowing users to make selections that are not currently functional.

5.1.3 The Details Window

One design principle that is often advanced for user interfaces suggests that masses of text should be avoided. However, in many cases, the instruction for a topic is most effectively presented in simple textual form. In this project, large blocks of text cannot be avoided—the nuances of each topic simply cannot be effectively presented any other way. In order to adhere to the minimal text mass guideline and still be able to present masses of text, another floating palette window has been included. This window is simply a scrolling text field. The details window is displayed as a result of a menu selection or a key press. The details window is displayed on top of all other windows. The user can read the text, leaving the window open if it is convenient or closing it if it is in the way.

One of the primary reasons for using these three windows was to take advantage of the different size screens available to Macintosh computers. Many Macintoshes have a small 9-inch screen. The main window exactly fills up this screen—when the other two windows are displayed, they are on top of the main window and must be closed to see the entire main window. On larger screens, the palette windows appear below and to the side of the main window, thus filling more of the larger screen. Users can move the windows anywhere they want and close the ones they do not want to see. Figure 12 shows the details window overlaid on an exploratory card.

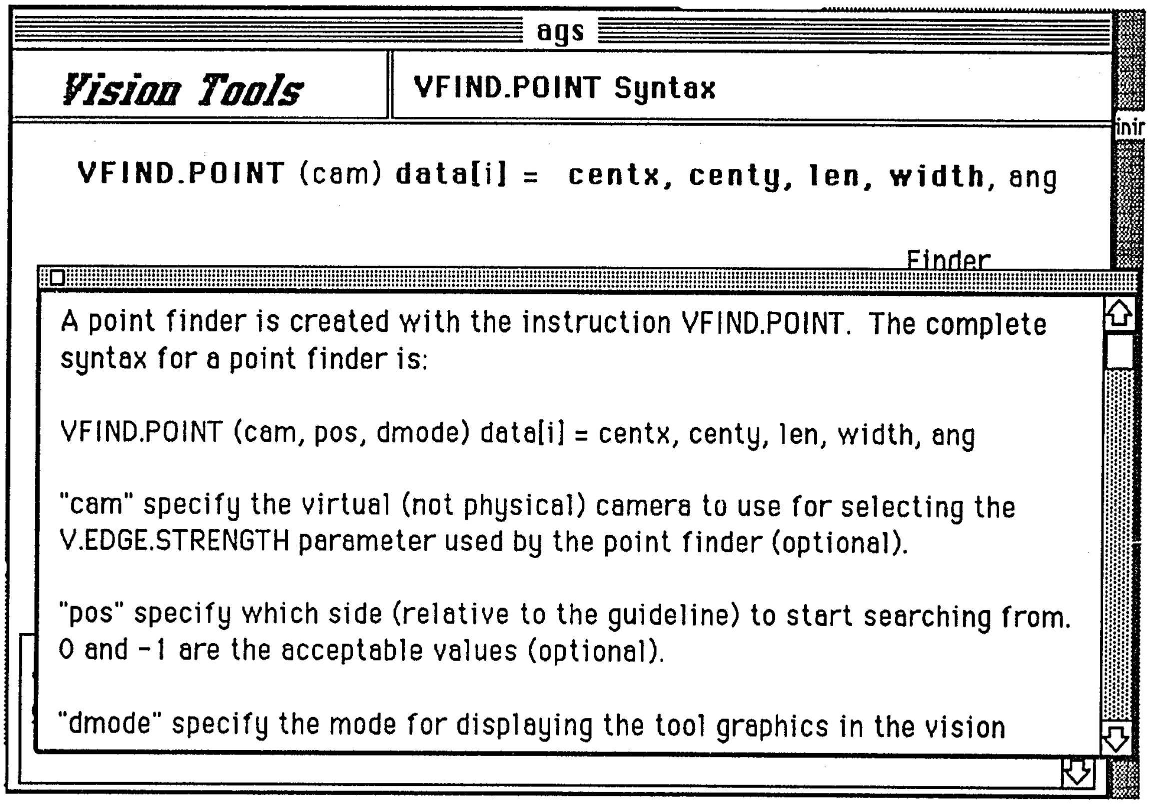

Figure 12. Details Window

5.2 Other Features of the "Road to Vision"

5.2.1 User Note Space

Many well-used reference texts will have: Notes written in the margins by the owner, "tacky notes" with reader comments tacked to various pages, or reader-generated material somehow attached to the text. This functionality has been generally absent from electronic information systems. The "Road to Vision" includes a text field on each page that allows users to make their own notes. Some advantages of this method over "margin notes" or "tacky notes" are: The space for notes is almost unlimited; the notes will never get lost; and the information system is not damaged by adding the notes. Figure 13 shows a sample of a comment form.

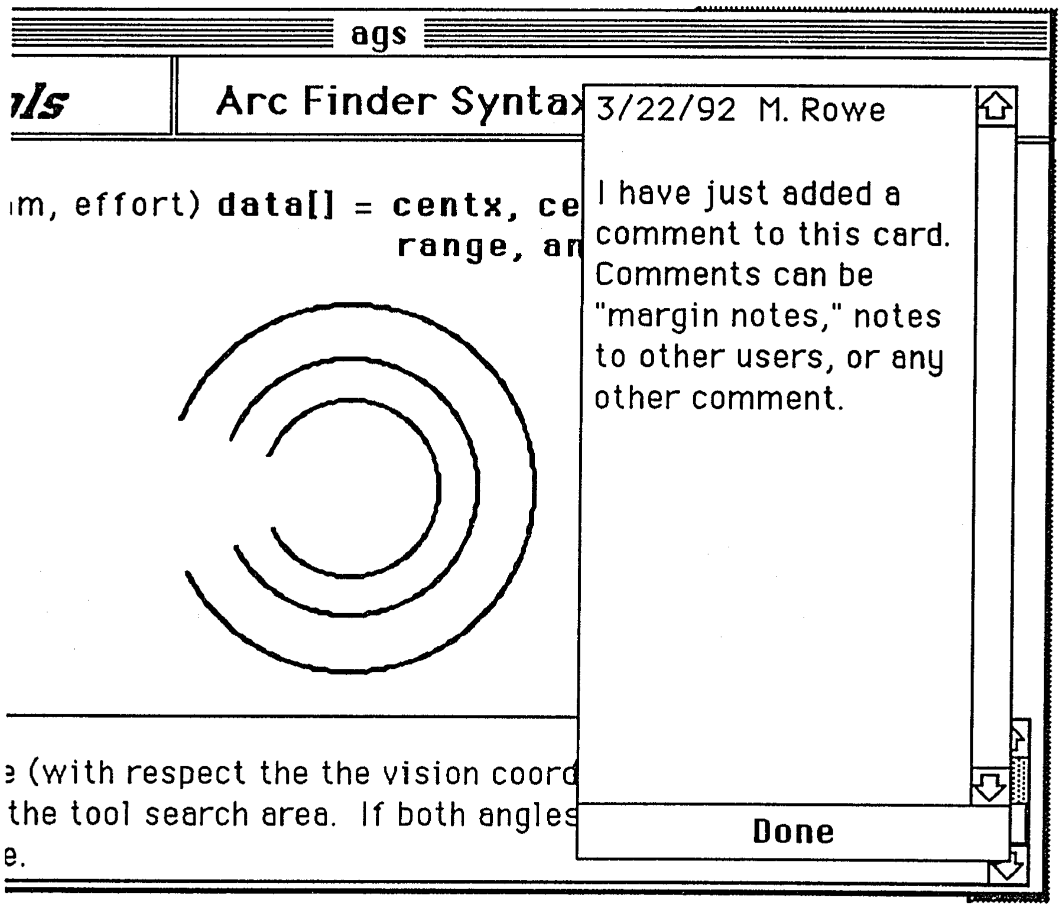

Figure 13. Sample Comments Form

5.2.2 The Main Menu Bar

The main menu bar has three top-level selections that provide navigational features and access to other features of the "Road to Vision." The first selection ("Goto") provides access to the "chapter" level pages of the system. It also duplicates the text search and placemarker functions of the navigation window. The second selection ("Show") displays and hides the navigation and details windows. The third selection ("Comments") allows entry and deletion of user comments.

5.2.3 Self Instructing

Other than basic installation instructions (see Appendix A), all the instructions needed to use the "Road to Vision" are contained in the first few cards in the project.

6
Formative Evaluation

The target audience for the formative evaluation of this project included: engineers who designed the machine vision system, engineers who implement systems, trainers who demonstrate the system, and clients who actually use the system.

Early on in the evaluation process, two major problems became obvious:

1. The project runs extremely slowly on currently available hardware. This made it difficult for the engineers and trainers to spend enough time with the system to evaluate it properly. "It just runs too slow," was the most common comment I heard.
2. Approximately 90 percent of the clients interested in testing the system did not have the correct hardware. (It's still an IBM PC world out there.)

6.1 Recommendations

The following recommendations were made by the various groups who reviewed the "Road to Vision"

- Add page numbers to each card. This idea expands on the book paradigm and is a logical extension of the project. It also shows that users perceived the parallels to printed materials.
- Supply print options for the various cards and details. This was an oversight in the original design. Often, only a small section of

material is of interest to a user and a printed page is the most efficient way of referencing this small section.

- Add all options available on the navigation window to the top-level menu bar. Reviewers using 9-inch screens found it inconvenient to have to close the navigation window to get it out of the way and then reopen it for use. There are key equivalents for each option, but key equivalents are usually used by advanced users who are very familiar with a system.
- Supply more help within the system regarding what would be the next logical step. The project is deficient in this regard—the only developed help is at the beginning, explaining how to physically use the system.
- Reviewers also pointed out several errors and bugs that required correction.

6.2 Conclusions

The initial reaction of reviewers who used the system was very positive. It seemed that almost everyone felt the need for a more efficient method of dealing with learning to use the machine vision system. However, the speed at which the system runs led most of the reviewers to conclude that printed material was still a more efficient method of accessing the information. This problem limited the value of the evaluation by the user groups. From the evaluations that were provided, the following conclusions were drawn:

- Making the enhancements listed in section 6.1 would greatly improve the usability of the project.

- The design principles used when creating the system seem sufficiently sound that a more carefully controlled and administered evaluation is warranted.
- One more round of hardware and software improvements will be needed before wide spread development of electronic information systems will be feasible. Given sufficient programming resources, current hardware platforms could support an electronic information system. However, before application development systems such as SuperCard are feasible for development (thus opening the development process to a much wider group), more computer "horsepower" will be needed. Also, the application development software will need to become more efficient.

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Appendix A
Instructions for Installing the "Road to Vision"

MEMO

TO: Road to Vision Users

FROM: Michael Rowe, 434-6229

DATE: 11-20-90

RE: Loading "Road to Vision"

The "Road to Vision" must be copied onto a hard drive and then expanded (for the version delivered on 800K floppies only). The steps are:

1. Place the "Road to Vision" disk in a floppy drive.
2. Double click on the drive icon to open the drive.
3. Drag the "Road to Vision" folder onto your hard drive.
4. Double click on the "Road to Vision" folder (on your hard drive) to open it.
5. Double click on the "Unstuffit" icon to start the decompression utility.
6. From the "Unstuffit" menu select **File ➡ Open**
7. In the window that is opened, highlight "Road to Vision (Stuffed)".
8. Click on the **Open** button.
9. A new window will be displayed. Highlight the "Road to Vision".
10. Click on the "Extract" button in the lower left corner of the window.

11. A new window will be displayed, click on the **Save** button.
12. From the "Unstuffit" menu select **File ➡ Quit**.
13. Put the "Road to Vision (Stuffed)" file and the "Unstuffit" utility in the trash.
14. Double click on the "Road to Vision" icon to start the program. Click on "Introduction" to see how the program works.

The minimum configuration to run the program is:

Mac SE, 2MB RAM (multi-finder turned off), 1MB free hard disk space.

The recommended configuration is:

Mac II (any flavor), 3 MB RAM, 1MB free hard disk space.